Remarks

I. Status of claims

Claims 1-22 were pending.

Claims 23-25 have been added.

II. Claim rejections under 35 U.S.C. § 102

The Examiner has rejected claims 1, 3-8, 10, 11, 13-15, 17-19, 21, and 22 under 35 U.S.C. § 102(e) over Hwang I (U.S. 2003/0185267).

A. Independent claim 1

In the rejection of claim 1, the Examiner has stated that (see page 3, line 8 - page 4, line 5 of the Office action):

> With respect to claims 1 and 15, Hwang discloses ... a cavity region disposed between the fist mirror and the second mirror and including an active light generation region 141 and a cavity extension region 122 and/or 160; wherein the longitudinal stack structure further includes an ion-implanted current confinement region 150 characterized by a peak longitudinal implant concentration separated from the cavity region by a longitudinal distance greater than 0.5 µm. It is noted that Hwang discloses the thickness of spacer 160 is about 0.25 to 2 µm (paragraph 43) and the thickness of the current confinement region 150 may be about ... 0.025 to 0.3 µm where the layer 150 is positioned in the upper half of the spacer. In case of the thickness of the spacer 160 is about more than 1 µm, the longitudinal distance must be greater than 0.05 µm. ...

Claim 1 has been amended and now recites that the cavity region extends from the first mirror to the second mirror and includes an active light generation region and a cavity extension region. The Examiner's rejection of claim 1 over Hwang I is premised on the assumption that the composite antiguide/current confinement structure 150 corresponds to the ion-implanted current confinement region recited in claim 1. The composite antiguide/current confinement structure 150, however, is located in a cavity region that extends from the first mirror to the second mirror. Thus, in accordance with the definition of the cavity region now defined in claim

1, the composite antiguide/current confinement structure 150 is not "separated from the cavity region by a longitudinal distance greater than 0.5 μm," as recited in claim 1.

For at least this reason, the Examiner's rejection of claim 1 under 35 U.S.C. § 102(e) over Hwang I now should be withdrawn. The rejection of claim 1 also should be withdrawn for the following additional reasons.

Independent claim 1 additionally recites that "the longitudinal stack structure further includes an ion-implanted current confinement region characterized by a peak longitudinal implant concentration separated from the cavity region by a longitudinal distance greater than 0.5 μm."

In paragraph 44, Hwang I explains that the composite antiguide/current confinement structure 150 is a stack of epitaxially grown semiconductor layers. In particular, the antiguide/current confinement structure 150 has a first p-type InP layer 161 that is epitaxially grown on the active region 141, a n-type InGaAsP layer 161 that is epitaxially grown on top of the first layer 161, and optionally a second p-type InP layer that is epitaxially grown on the n-type InGaAsP layer 151. It is well-known in the art of semiconductor device manufacturing that the epitaxial growth of doped semiconductor layers as described in Hwang I does not involve creating an ion-implanted current confinement region. Therefore, one skilled in the art would have understood from the disclosure of Hwang I that the composite antiguide/current confinement structure 150 shown in FIG. 1 does not include an ion-implanted current confinement region, as recited in claim 1 (see, e.g.: "In the embodiment of FIG. 1, the annular antiguide structure serves as the entire resistive annular portion of the current-confinement structure).

In paragraph 66, Hwang I explains that an alternative device may include, in addition to the composite antiguide/current confinement structure 151, an annular resistive section 401 that also blocks current flow (see FIG. 4). The annular resistive section 401 may be an oxidized or ion-implanted section of the material of the top spacer (see ¶ 66, lines 16-18). Hwang I, however, does not teach or suggest where this ion-implanted section of spacer layer material is in relation to the active region 153. In this case, there is no basis for assuming that the annular resistive section 401 constitutes "an ion-implanted current confinement region characterized by a peak longitudinal implant concentration separated from the cavity region by a longitudinal

distance greater than 0.5 μm." Indeed, based on the thinness (20 nm; see ¶ 44) of the top spacer portion 162, one skilled in the art reasonably would have understood that the ion-implanted section is formed in the bottom spacer layer portion 161; but Hwang I does not provide any guidance where the peak longitudinal implant concentration should be located in the depth of the bottom spacer layer portion 161.

For at least these additional reasons, the Examiner's rejection of independent claim 1 under 35 U.S.C. § 102(e) over Hwang I should be withdrawn.

B. Claims 3-8, 10, 11, 13, and 21

Each of claims 3-8, 10, 11, 13, and 21 incorporates the features of independent claim 1 and therefore is patentable over Hwang I for at least the same reasons explained above.

C. Independent claim 14

Independent claim 14 recites that "the longitudinal stack structure further includes an ion-implanted current confinement region characterized by a peak longitudinal implant concentration separated from the cavity region by a longitudinal distance greater than 0.5 μm."

In paragraph 44, Hwang I explains that the composite antiguide/current confinement structure 150 is a stack of epitaxially grown semiconductor layers. In particular, the antiguide/current confinement structure 150 has a first p-type InP layer 161 that is epitaxially grown on the active region 141, a n-type InGaAsP layer 161 that is epitaxially grown on top of the first layer 161, and optionally a second p-type InP layer that is epitaxially grown on the n-type InGaAsP layer 151. It is well-known in the art of semiconductor device manufacturing that the epitaxial growth of doped semiconductor layers as described in Hwang I does not involve creating an ion-implanted current confinement region. Therefore, one skilled in the art would have understood from the disclosure of Hwang I that the composite antiguide/current confinement structure 150 shown in FIG. 1 does not include an ion-implanted current confinement region, as recited in claim 14 (see, e.g.: "In the embodiment of FIG. 1, the annular antiguide structure serves as the entire resistive annular portion of the current-confinement structure).

In paragraph 66, Hwang I explains that an alternative device may include, in addition to the composite antiguide/current confinement structure 151, an annular resistive section 401 that

also blocks current flow (see FIG. 4). The annular resistive section 401 may be an oxidized or ion-implanted section of the material of the top spacer (see ¶ 66, lines 16-18). Hwang I, however, does not teach or suggest where this ion-implanted section of spacer layer material is in relation to the active region 153. In this case, there is no basis for assuming that the annular resistive section 401 constitutes "an ion-implanted current confinement region characterized by a peak longitudinal implant concentration separated from the cavity region by a longitudinal distance greater than 0.5 μm." Indeed, based on the thinness (20 nm; see ¶ 44) of the top spacer portion 162, one skilled in the art reasonably would have understood that the ion-implanted section is formed in the bottom spacer layer portion 161; but Hwang I does not provide any guidance where the peak longitudinal implant concentration should be located in the depth of the bottom spacer layer portion 161.

For at least these reasons, the Examiner's rejection of independent claim 14 under 35 U.S.C. § 102(e) over Hwang I should be withdrawn.

D. Independent claim 15

Each of independent claims 14 and 15 recites features that essentially track the pertinent features discussed above in connection with independent claim 1 and, therefore, is patentable over Hwang I for at least the same reasons.

E. Claims 17-19 and 22

Each of claims 17-19 and 22 incorporates the features of independent claim 15 therefore is patentable over Hwang I for at least the same reasons explained above.

III. Claim rejections under 35 U.S.C. § 103

A. Claims 2, 9, 16, and 20

The Examiner has rejected claims 2, 9, 16, and 20 under 35 U.S.C. § 103(a) over Hwang I in view of Sun (U.S. 6,144,682).

Each of claims 2 and 9 incorporates the features of independent claim 1 and each of claims 16 and 20 incorporates the features of independent claim 15. Sun does not make-up for the failure of Hwang I to teach or suggest the features of independent claims 1 and 15 discussed above. Therefore, claims 2, 9, 16, and 20 are patentable over Hwang I and Sun for at least the

same reasons explained above. These claims also are patentable over Hwang I and Sun for the following additional reasons.

1. Claims 2 and 16

Claim 2 recites that a metal contact is disposed on the light emitting surface and defines an aperture, wherein the ion-implanted current confinement region defines a current aperture larger than the aperture of the metal contact.

Claim 16 recites "forming on the light emitting surface a metal contact defining an aperture, wherein the ion-implanted current confinement region defines a current aperture larger than the aperture of the metal contact."

The Examiner has explained the basis of his rejection of claims 2 and 16 as follows (see page 6, lines 3-12 of the Office action):

> With respect to claims 2 and 16, Hwang discloses the claimed invention except for a metal contact disposed on the light emitting surface and defining an aperture, wherein the ion implanted current confinement region defines a current aperture larger than the aperture of the metal contact. Sun discloses in Fig. la VCSEL with an implantation region 114 defining a current confinement region and further two a metal contact 142 disposed on the light emitting surface and defining an aperture, wherein the ion-implanted current confinement region defines a current aperture 120 larger than that of the metal contact 134. It would have been obvious to the one having ordinary skill in the art at the time the invention was made to provide a metal contact defining the aperture smaller than that of the current aperture in order to reduce the higher modes of the VCSEL.

Contrary to the Examiner's statement, however, Sun's disclosure would not have led one skilled in the art to modify Wang's device to include a metal contact and the ion-implanted current confinement region defines a current aperture larger than the aperture of the metal contact. In particular, Sun teaches that the gold contact 142 is used to block transmission of higher order lasing modes, which "extend further outside the output window" (col. 4, line 19; see also col. 4, lines 25-27). In Hwang I, on the other hand, the composite antiguide/current confinement structure 150 achieves the higher order lasing mode suppression through the use of different indices of refraction for the top spacer layer 160 and the antiguide structure 151 (see ¶¶

56, 60). Thus, one skilled in the art would not have seen any need for making the top contact 145 in Hwang I with an aperture that is smaller than the current aperture defined by the antiguide structure 151. In fact, such a modification of Hwang I's teachings only would have served to suppress the fundamental TEM laser mode and, thereby, detrimentally affect the performance of the devices disclosed in Hwang I.

For at least these reasons, the Examiner's rejection of claim 2 and 16 under 35 U.S.C. § 103(a) over Hwang I in view of Sun should be withdrawn.

2. Claims 9 and 20

Each of claims 9 and 20 recites that "the cavity extension region is disposed adjacent to the second mirror and has the same material composition as one of the different refractive index materials in the second mirror stack."

The Examiner has explained the basis of his rejection of claims 2 and 16 as follows (see page 6, lines 3-12 of the Office action):

> With respect to claims 9 and 20, Sun discloses the implanted region 116 and the mirror 114 being made of AlGaAs and AlAs which is the same material composition as that of the implanted region.

With this rejection, however, the Examiner has not established a proper *prima facie* case of obviousness under 35 U.S.C. § 103(a) in accordance with MPEP § 706.02(j) because the Examiner has not provided the requisite factual basis and not established the requisite motivation to support his deemed conclusion that the features recited in claims 9 and 20 would have been obvious to one of ordinary skill in the art at the time of the invention. The Examiner's implied position that it would have been obvious to modify the teachings of Sun because "Sun discloses the implanted region 116 and the mirror 114 being made of AlGaAs and AlAs which is the same material composition as that of the implanted region" does not meet the Examiner's obligation to point to some teaching or suggestion in Hwang I or Sun or in the knowledge generally available that would have led one of ordinary skill in the art to the invention recited in claims 9 and 20. The mere fact that "Sun discloses the implanted region 116 and the mirror 114 being made of AlGaAs and AlAs which is the same material composition as that of the implanted region" would not have motivated one skilled in the art at the time of the invention to modify the

material composition of the antiguide structure 151 or the top DBR 148 of the lasers disclosed in Hwang I. Indeed, none of the cited references provides any basis for believing that such a modification would have served any useful purpose whatsoever.

Without a proper explanation for combining Hwang I and Sun to arrive at the invention recited in claims 9 and 20, the Examiner has not established a proper *prima facie* case of obviousness and the rejection of claims 9 and 20 under 35 U.S.C. § 103(a) over Hwang I a in view of Sun should be withdrawn.

B. Claim 12

The Examiner has rejected claim 12 under 35 U.S.C. § 103(a) over Hwang I and Hwang II (U.S. 2003/0091083).

Claim 12 incorporates the features of independent claim 1.

Hwang II does not make-up for the failure of Hwang I to teach or suggest the features of independent claim 1 discussed above. For example, the Examiner's rejection of claim 12 over Hwang II is premised on the assumption that the current confinement structure 412 (see FIG. 4) corresponds to the ion-implanted current confinement region recited in claim 1. The current confinement structure 412, however, is located in a cavity region that extends from the first mirror 680 to the second mirror 120 (see FIG. 6). Thus, in accordance with the definition of the cavity region now defined in claim 1, the current confinement structure 412 is not "separated from the cavity region by a longitudinal distance greater than 0.5 μm," as recited in claim 1.

For at least this reason, the Examiner's rejection of claim 12 under 35 U.S.C. § 103(a) over Hwang I and Hwang II now should be withdrawn.

IV. Conclusion

For the reasons explained above, all of the pending claims now are in condition for allowance and should be allowed.

Charge any excess fees or apply any credits to Deposit Account No. 50-3718.

Respectfully submitted,

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Edouard Garcia
Reg. No. 38,461
Telephone No.: (650) 289-0904

Please direct all correspondence to:

Avago Technologies, Inc.
c/o Klass, Law, O'Meara & Malkin, P.C.
PO Box 1920
Denver, CO 80201-1920